CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM (CERES)

CERES VALIDATION PLAN

MONTHLY REGIONAL TOA AND SURFACE RADIATION BUDGET (SUBSYSTEM 10.0)

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10.0 MONTHLY REGIONAL TOA AND SURFACE RADIATION BUDGET

10.1 INTRODUCTION

10.1.1 Measurement and science objectives

The science objective of the monthly mean top-of-atmosphere (TOA) and surface radiation budget (SRB) averages data product is to accomplish the dual goals of providing a stable, long-term monthly mean data set of shortwave (SW) and longwave (LW) radiative parameters at the TOA and surface using a data processing system consistent with the Earth Radiation Budget Experiment (ERBE) and, at the same time, producing the most accurate monthly mean data set currently available based on state-of-the-art techniques. To accomplish these goals, CERES will produce regional, zonal, and global means by both the ERBE-like technique and the geostationary-enhancement method.

10.1.2 Missions

The CERES instruments will be flown on multiple satellites, which include TRMM, EOS AM-1, and EOS PM-1, to provide the diurnal sampling necessary to obtain accurate monthly averages of the TOA radiative parameters.

10.1.3 Science data products

The CERES TISA data algorithm for Subsystem 10 produces the monthly TOA and SRB average data product (SRBAVG) which contains monthly and monthly-hourly regional, zonal, and global averages of the TOA and surface LW and SW fluxes and the observed cloud conditions for each 1.0 degree equal-angle region. This product differs from the AVG product in Subsystem 8 in three ways. First, the surface fluxes are calculated from the TOA fluxes using parameterizations provided by the science team, instead of using the models provided by the SARB subsystem. Second, no flux fields are calculated at levels between the TOA and surface. Lastly, the regional fluxes are calculated using both the ERBE-like method and the geostationary data enhancement technique. There is an SRBAVG product for each spacecraft and for each combination of spacecraft. There are 69 data parameters in each of the SRBAVG data products. These include mean estimates of SW and LW radiant flux at the TOA and at the surface from both of the methods, column-averaged cloud properties, the standard deviations of these estimates, location and scene types. A complete list of data parameters is in the CERES Data Products Catalog.

In the next section, we will discuss the method adopted by the CERES Time Interpolation and Spatial Averaging (TISA) working group for validating the SRBAVG data product. Section 10.3

and 10.4 outline both pre-launch and post-launch validation studies. Section 10.5 provides details on implementing validation results in data production. A summary is given in Section 10.6.

10.2 VALIDATION CRITERION

10.2.1 Overall approach

The science algorithms for TOA parameters are based on the ERBE-like technique (Subsystem 3.0) and the new CERES geostationary-enhancement method (Subsystem 7.0). A few minor differences do exist. For example, the input data for this subsystem are derived from the SFC data product instead of the FSW. In addition, the data are sorted in terms of local time, not GMT. The first step in the averaging algorithms is to sort the data in space and local time. The regriding of the geostationary data is then done in a manner similar to Subsystem 7. Column-averaged cloud data are time interpolated to all local times using a linear technique. The complete time series of column-averaged data is used to compute monthly and monthly-hourly means. Monthly means of the Angular Model Scene Class data are computed using only data from the times of CERES observations. The temporal interpolation of total-sky LW and SW fluxes is identical to the technique described in Subsystem 3 (ERBE-like technique) and Subsystem 7 (new CERES geostationary-enhancement method). However, estimates of daily regional SW flux from the new CERES method are made only for days with at least one CERES observation. Only these days will be used in the calculation of new CERES geostationary enhanced monthly mean fluxes. Time interpolation of clear-sky LW and SW flux are done using ERBE-like method only. No attempt is made to produce clear-sky flux estimates at every hour. Only days with at least one clear-sky flux measurement are modeled and used in the computation of monthly means. Surface SW and LW fluxes are calculated based on TOA-surface parameterization schemes for every hour in which a TOA flux is calculated. Monthly, monthly-hourly, and daily means are computed in the same manner as used for TOA flux. Once regional means are computed for all parameters and all CERES 1-degree equal angle gridded regions, these means are combined into zonal and global means using weighting factors to correct for variations in grid box size with latitude. There are three input data sets to this subsystem. They include atmospheric structure data set (ASTR), ISCCP radiance data set (GEO), and hourly gridded single satellite TOA and surface fluxes data set (SFC). The output of the data processing system produces the monthly TOA and SRB averages data set (SRBAVG).

The overall approach to validating the SRBAVG data product follows very closely to the method outlined in the validation plan for the ERBE-like data product (Subsystem 3.0) and will not be repeated here. Readers are referred to Subsystem 3 for more details.

In order to conserve resources, the CERES TISA working group will not validate every data parameter listed in the SRBAVG science products. The data parameters used here for validation purposes are:

(a) the LW and SW TOA all-sky flux,

(b) the LW and SW TOA clear-sky flux,
(c) the LW and SW surface all-sky flux, and
(d) the LW and SW surface clear-sky flux.

10.2.2 Sampling requirements

In order to validate SRBAVG data product, we will require a minimum of one year of data from each of the CERES satellites. Additional data months are also required to perform data consistence test between different satellites (i.e., TRMM against AM, TRMM against PM, and AM against PM).

10.2.3 Measures of success

Accuracy goals for the monthly mean surface and TOA radiative parameters are based closely to those described in Subsystem 3 (ERBE-like method), 4.6 (surface radiation budget), and 8 (geostationary-enhancement technique) and will not be repeated here. Readers are referred to the validation plan of those subsystems for more details.

10.3 PRE-LAUNCH ALGORITHM TEST/DEVELOPMENT ACTIVITIES

Pre-launch data for validating the TOA fluxes are outlined in Subsystem 3 (ERBE-like method), 4.6 (surface radiation budget) and 7 (geostationary-enhancement technique) and will not be repeated.

10.4 POST-LAUNCH ACTIVITIES

The post-launch validation of this subsystem is similar to those given in Subsystem 3 (ERBE-like method), 4.6 (surface radiation budget) and 7 (geostationary-enhancement technique) and will not be repeated. Readers are referred to those subsystems for further details

10.5 IMPLEMENTATION OF VALIDATION RESULTS IN DATA PRODUCTION

The implementation of TISA validation results is given in Subsystem 7 and will not be repeated. Readers are referred to that subsystem for further details

10.6 SUMMARY

This document describes a plan for validating the CERES SRBAVG data product. This plan is based on method and procedures outlined in Subsystem 3, 4.6, and 7. Readers are referred to those subsystems for further details.

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10.0 MONTHLY REGIONAL TOA AND SURFACE RADIATION BUDGET

DATA PRODUCTS/PARAMETERS

- Monthly and monthly-hourly regional, zonal, and global averages of the TOA and surface LW and SW fluxes and the observed cloud conditions for each of the CERES region.

MISSION

- TRMM, EOS AM-1, and EOS PM-1.

APPROACH

- Complete pre-launch science studies for improving and verifying TISA methods.
- Verify input/output operations and interface compatibility with other subsystems.
- Compare results with validation data set.

PRELAUNCH

- Complete validation of the science algorithm.
- Finish testing of the data processing system.
- Verify TOA results with historical ERBE TOA scanner data.
- Perform case study using CAGEX data to verify science algorithm.
- Validate data processing system using CERES end-to-end simulation.

POST-LAUNCH

- Primary comparison of TOA fluxes with geostationary data using narrowband-to-broadband conversion technique.
- Secondary direct verification of TOA fluxes (if available) with ERBE WFOV results, ScaRaB data, and GERB data.
- Comparison with cloud and radiation data collected from intensive field experiments (i.e., TOGA, FIRE, CAGEX, ARM/TWP, ARM/NSA, and UAV experiments).
- Comparison with cloud and radiation data collected for special validation regions; including class 1 and class 2 sites (i.e., Walker Towers, Boulder Tower, NOAA sites, and BSRN sites).
- Additional intercomparison between TRMM, EOS AM-1, and EOS PM-1 data.
- Continuous monitoring of the quality of the input data product and detecting problems in the overall system.

EOSDIS

- Special processing of CERES SRBAVG data products containing validation sites.